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1 APPARATUS AND METHOD FOR APPLYING SURGICAL
 STAPLES TO ATTACH AN OBJECT TO BODY TISSUE

CROSS REFERENCE TO RELATED APPLICATION

 This application is a continuation-in-part of co-
pending application U.S. Serial No. 07/782,290, filed on
5 October 18, 1991.

BACKGROUND OF THE INVENTION

1. Field of the Invention

 The present invention relates to an apparatus and
method for applying surgical staples to attach objects to
10 body tissue. More particularly, this invention relates to a
staple applier particularly adapted for attaching surgical
mesh to body tissue to reinforce a surgical repair of the
body tissue, as in hernia repair.

2. Background of the Invention

15 Hernias may be divided into three general classes:
direct hernia, indirect hernia and femoral hernia. In a
direct or indirect inguinal hernia, often a part of the
intestine protrudes through a defect in the supporting
abdominal wall to form a hernial sac requiring surgery which
20 generally includes a surgical incision in the groin ranging
up to six inches in length. Several layers of the abdominal
wall are generally separated to reach the herniated
portions. During the procedure, the hernia is closed
outside the abdominal wall in a manner which resembles the
25 tying of a sack at the neck. Often a surgical mesh is
attached by sutures directly over the hernia repaired
opening to provide a reinforcement to the opening.

 Traditionally, such hernia repairs involved major
invasive surgical procedures which often caused excessive
30 trauma to the patient and necessitated unusually long post-
operative recuperative periods. In addition, numerous

1 complications, related directly or indirectly to the surgery
often resulted, including bleeding, infection, testicular
atrophy, organ damage, nerve damage, blood vessel damage,
etc. Further, cutting through the numerous layers of tissue
5 to obtain access to the herniated area often caused severe
trauma to the patient. A detailed discussion of traditional
hernia repair may be found in "Hernia Repair Without
Disability, Second Edition", by Irving L. Lichtenstein.

Such invasive surgical procedures have also been
10 utilized in other areas of the body, including surgery on
the gall bladder, appendix, lungs and the like. For the
reasons previously stated, the use of laparoscopic and
endoscopic surgical procedures have been relatively popular
and such popularity has provided additional incentive to
15 develop the procedures further.

In laparoscopic procedures, surgery is performed
in the interior of the abdomen through a small incision; in
endoscopic procedures, surgery is performed in any hollow
viscus of the body through narrow endoscopic tubes inserted
20 through small entrance wounds in the skin. Laparoscopic and
endoscopic procedures generally require that any
instrumentation inserted into the body be sealed, i.e.,
provisions must be made to ensure that gases do not enter or
exit the body through the laparoscopic or endoscopic
25 incision as, for example, in surgical procedures in which
the surgical region is insufflated. Moreover, laparoscopic
and endoscopic procedures often require the surgeon to act
on organs, tissues and vessels far removed from the
incision, thereby requiring that any instruments be used in
30 such procedures be long and narrow while being functionally

1 controllable from one end of the instrument, i.e. the
proximal end.

In hernia surgery, as compared to gall bladder
surgery, certain procedures and instruments are the same,
5 yet certain of the instrument requirements differ. For
example, in hernia surgery a suitable mesh material is
generally sutured over the opening in the tissue. The mesh
material is often also attached by sutures and left within
the opening to act as a reinforcing agent for tissue
10 regrowth in the area of the surgery. One example of a mesh
material currently utilized in hernia surgery includes a
polypropylene material marketed by the Ethicon division of
Johnson & Johnson, New Brunswick, New Jersey, under the
trademark MARLEX. Another example of a mesh material is a
15 tri-fluoroethylene material marketed by W.L. Gore &
Associates, Newark, Delaware, under the trademark GORE-TEX.

As noted, during conventional invasive surgical
procedures, such mesh materials are often sutured within the
surgical opening or over the sutured opening by conventional
20 suturing techniques. However, with the advent of
laparoscopic surgery the need for suitable mesh attachment
techniques through the relatively narrow endoscopic tubes or
cannulas is clearly defined. Up to the present, such
devices or staples suitable for mesh attachment have not yet
25 been developed.

U.S. Patent No. 4,944,443 to Oddsen et al.
discloses an instrument and method for applying and forming
staples into body tissue to suture a hernial opening. The
staple is applied to two pieces of body tissue on opposite
30 sides of the opening which are gripped, approximated and
held together by a tissue positioning assembly. U.S. Patent

1 No. 4,919,152 to Ger relates to a surgical instrument for
placing a single clip which is proposed for use in direct
hernia repair for closing sacs having narrow neck openings.

5 Up to the present there remains a need for an
apparatus which is particularly adapted to endoscopically
apply staples for attaching objects such as surgical mesh to
body tissue in a manner to positively secure the object to
the body tissue without danger of separation thereof after
the attachment is completed. The present invention relates
10 to such an apparatus as well as a method for attaching such
objects with staples particularly configured and adapted to
accomplish these objectives.

SUMMARY OF THE INVENTION

15 An apparatus for endoscopic application of a
surgical staple adapted to attach objects to body tissue,
which comprises frame means, generally elongated endoscopic
means connected to the frame means and extending distally
therefrom, means for storing at least one surgical staple at
20 the distal end portion, the staple configured and adapted to
attach an object to body tissue, means for individually
advancing the at least one staple distally for positioning
adjacent the body tissue, and anvil means for closing the
staple in a manner to encompass at least a portion of the
25 object and to penetrate the body tissue to attach the
portion of the object to the body tissue. Preferably, the
apparatus for endoscopic application of surgical staples is
adapted to attach surgical mesh to body tissue and comprises
means for storing a plurality of surgical staples in
30 generally stacked relation to permit configuring and
dimensioning the endoscopic means for insertion into an

1 endoscopic cannula tube. The staples are configured and
adapted to attach the surgical mesh to body tissue,
particularly for hernia related surgery. Further, the
staple advancing system extends from the frame means to the
5 endoscopic means and is activated by a trigger mechanism
pivotaly attached to the frame means and forming a part
thereof.

The surgical staples are stored in stacked
relation at the distal end of the endoscopic means. Also,
10 the endoscopic means defines a longitudinal axis and the
surgical staples are stacked to form an angle with the
longitudinal axis, thereby improving visibility.

The surgical staple storing means is pivotaly
attached at the distal end portion of the endoscopic means
15 wherein the surgical staple storing means is selectively
pivotal by the user. Pivotal control means is located at
the proximal end of the endoscopic section to pivot the
surgical staple storing means from a proximal location. The
location of the pivotal control means is provided for
20 convenience and accessibility to the operator. The pivotal
control means of the staple storing means comprises a member
movable with respect to the endoscopic means in proximal and
distal directions and adapted to position said surgical
staple storing means at substantially zero degrees with
25 respect to said longitudinal axis when said pivotal control
means is in a first position and said surgical staple
storing means forms an angle of up to about 45 degrees when
said pivotal control means is in a second position.

The first position may be the proximalmost
30 position of the pivotal control means and the second
position may be the distalmost position corresponding to the

1 staple storing means being pivoted up to about 45 degrees
with respect to at least one side of the longitudinal axis.
Further, the pivotal control means of the staple storing
means may include a generally cylindrical movable member
5 slidably positioned about a proximal portion of the
endoscopic means.

The staple storing means may also comprise a
rotatable sleeve positioned within the movable member and
adapted to rotate in a first direction when the movable
10 member is moved toward the proximalmost position and to
rotate in the opposite direction when the movable member is
moved toward the distalmost position.

The surface at the distalmost end portion of the
rotatable sleeve may form an angle with respect to the
15 longitudinal axis of the endoscopic means and the distalmost
end surface of the rotatable sleeve may be positioned and
arranged to engage elongated control means positioned within
the endoscopic means for engagement with at least a portion
of the staple storing means at a distal location of the
20 endoscopic means whereby rotatable movement of said
rotatable sleeve correspondingly produces longitudinal
movement of said elongated control means. Preferably, the
elongated control means comprises at least two elongated
rods positioned within the endoscopic means and in
25 engagement with the distalmost end portion of the rotatable
sleeve at the proximal ends thereof and arranged to engage
at least a portion of the staple storing means at
respectively opposed locations such that rotation of the
rotatable sleeve in a first direction produces distal
30 movement of at least one of the rods and corresponding
proximal movement of the other rod and rotation of the

1 rotatable sleeve in the opposite direction respectively
produces correspondingly respectively opposite movement of
the rods.

The staple storing means includes an indentation
5 adapted to receive each rod in engagement therewith and each
rod is correspondingly configured at the distal end to
engage the respective indentation to produce smooth rotation
of the staple storing means when the rods are respectively
moved distally and proximally. Further, the means for
10 individually advancing the staples distally is user
controllable at a proximal location. The means for
individually advancing said staples distally comprises a
plate member positioned adjacent and proximal of the
lowermost staple and adapted to be movable distally whereby
15 the plate member engages the lowermost staple and advances
the staple in the distal direction. Also, the means to
individually advance the staples comprises staple pusher
means, which comprises said plate member and the plate member
is dimensioned, configured and arranged to engage and
20 advance each staple distally.

The staple pusher means includes an elongated
member of super elastic material such as NITINOL brand metal
and is adapted to advance the staples and transmit closing
force thereto. This member is further adapted to
25 resiliently deform to facilitate pivoting movement to the
staple storing means. The staple pusher means further
comprises an elongated staple firing rod.

In the preferred apparatus the staple pusher means
is biased to a pre-fired position by a constant force
30 negator spring which prevents the operator tendency to
rotate the hand, which occurs when a spring force increases.

1 Also a trigger mechanism is pivotally mounted for
pivotal movement against the force of the negator spring
when pivoted proximally to a position corresponding to
advancing the pusher means distally to advance the staple
5 next in line for closure.

The staple storing means includes anvil means
positioned distally of the stack of staples and configured,
dimensioned and adapted to be engaged by each said staple
when said staple is advanced distally by said plate member.

10 The staples are each formed of a first length of
wire having at least two leg portions at each end extending
generally perpendicular to said first length of wire. The
anvil means comprises at least two upstanding leg members
positioned to be engaged by the first length of wire of each
15 staple when the staple is advanced distally by the plate
member. The leg members of the anvil means are dimensioned,
positioned and arranged such that engagement by the first
length of wire of each staple causes the leg members of the
staple to fold inwardly toward the first wire due to the
20 configuration of the staple and the corresponding
configuration of the distalmost staple engaging edge of the
plate member. The plate member is connected to elongated
means comprised of super elastic member and the firing rod.

25 The means to move the elongated means and the
plate member in distal and proximal directions is positioned
within the frame means. Resilient means is positioned below
each staple such that upon completion of closure thereof,
and withdrawal of the staple advancing plate member the
resilient means resiliently lifts the staple above the level
30 of the anvil means. Also, the elongated means extends from
the frame means through the endoscopic means whereby a

1 distal portion thereof and the plate member are positioned
within the staple storing means. The means to advance the
elongated means and the plate member includes ratchet and
5 associated pawl means adapted to prevent proximal movement
thereof except when the staple advancing means is advanced
to the distalmost position whereby the pawl means is
released so as to permit return of the elongated member and
the staple advancing plate member to the proximalmost
position to advance the next staple of the stack of staples.

10 Preferably, the ratchet and pawl means comprises a
ratchet member fixedly connected to the frame means and has
a ribbed surface, and pawl means connected to the elongated
plate advancing means and positioned adjacent the ratchet
member and adapted to engage the ribbed surface. The ribbed
15 surface is correspondingly configured and dimensioned to
prevent proximal movement of the pawl means when the
elongated plate advancing means is advanced at least
partially in the distal direction. The ribbed surface of
the ratchet member is comprised of a plurality of
20 substantially and successive V-shaped peaks and valleys and
the pawl means is configured at one end portion to engage
the peaks and valleys in a manner which permits distal
slidable movement thereof but prevents proximal movement
thereof. Also, means is provided to release the pawl means
25 when the pawl means is in the distalmost position
corresponding to the distalmost position of the plate member
and closure of the staple has been completed. A finger
operative lever is adapted to produce distal movement of the
elongated member and the plate member when said lever is
30 pivotally moved.

1 The frame means has a pistol-like shape and
includes a first member having a distal end connected to the
endoscopic means and a manually gripping member at the
proximal end is adapted to be gripped manually by the user.

5 The endoscopic means is rotatable about the longitudinal
axis and the pivotal control sleeve of the staple storing
means is connected for rotation with the endoscopic means
such that rotation thereof produces corresponding rotation
of said endoscopic means. As described hereinabove, distal
10 and proximal movement thereof produces pivotal movement of
the staple storing means. The staple storing means is
adapted to be pivoted up to about 45 degrees with respect to
each side of the longitudinal axis whereby full pivotal
articulation thereof is provided of about 90 degrees.

15 A surgical staple is adapted to attach objects
such as mesh materials to body tissue which comprises, a
length of wire having a central portion, a wire leg member
extending generally perpendicular to the central wire
portion at each end portion and adapted to penetrate the
20 object and body tissue when positioned in adjacent engaged
relation therewith and advanced thereinto. A bridge portion
connects the central wire portion to each leg member and has
a first generally arcuate portion generally concave and
facing in a direction generally toward the center of the
25 central wire portion. The inwardly facing concave
portions are connected to each leg member by an arcuate
portion having a generally concave configuration in the
opposite direction so as to respectively engagably support
each bridge portion against a pair of anvil members whereby
30 applying force to the bridge portions causes the leg members
to bend inwardly toward the central wire portion at

1 respective locations inward of the first mentioned arcuate
portions in a manner to form an acute angle relative
thereto. The maximum distance between the central wire
portion and each folded leg member is sufficient to grip the
5 object and to penetrate the body tissue sufficient to attach
the object to the body tissue. Each said leg member has a
pointed tip to penetrate the object and the body tissue.

Each leg member of the staple has a tapered
portion at the free end. The tapered portion on one leg
10 member is located opposite the tapered portion on the other
leg member whereby folding the leg members inwardly toward
each other causes each tapered portion to respectively cam
the other leg member whereby the leg members are folded
toward each other in adjacent relation without interference
15 with each other. The central wire portion is positioned
inwardly of each bridge portion to facilitate gripping the
object between the central wire portion and the leg members.
Further, each leg member has a generally arcuate shape and
has a concave portion thereof generally facing the other leg
20 member. The surgical staple is preferably made of titanium.
Also, the central wire portion includes a portion thereof
which is positioned inwardly of the bridge portions in the
body tissue gripping direction to thereby form a bight
portion for gripping the object and body tissue in
25 combination with the leg members.

A method is disclosed for endoscopically applying
surgical staples to attach objects such as surgical mesh to
body tissue comprising the steps of storing at least one
surgical staple in endoscopic means having storing means
30 positioned at the distal end portion and adapted for
advancing and closing said staple, positioning the object

1 adjacent the body tissue for attachment to the body tissue,
and advancing the surgical staple distally so as to
penetrate the object and the body tissue and to close the
staple in a manner to attach the portion of the object to
5 the body tissue. Preferably, a plurality of surgical
staples are stored in stacked relation in the endoscopic
means.

The invention relates to the combination of a
cannula adapted for insertion into a body cavity, the
10 cannula including valve means for sealing the cannula. An
endoscopic surgical staple applier has a frame, and an
endoscopic portion defining a longitudinal axis, and
extending distally from the frame, the endoscopic portion
configured and adapted for insertion into the cannula
15 through the valve means in sealing engagement therewith.
The endoscopic portion further includes a plurality of
surgical staples in stacked relation, and means for
individually pushing the staples through the distal end
thereof is provided whereby staple closing means causes the
20 staples to be closed while attaching an object such as
surgical mesh to the body tissue. Seal means is positioned
and adapted to obstruct passage of gaseous media from the
body cavity.

A kit is also disclosed for endoscopic application
25 of a surgical staple adapted to attach surgical mesh to body
tissue in hernia repair, which comprises, surgical mesh,
cannula means, and apparatus for endoscopic application of a
surgical staple adapted to attach the surgical mesh to body
tissue. The apparatus and staples of the kit are
30 constructed according to the invention. The components may

1 be supplied as part of a kit or they may be packaged in a
blister-type or other package.

In an alternative embodiment, an apparatus is disclosed for endoscopic application of a surgical staple
5 adapted to attach an object to body tissue, which comprises frame means, generally elongated endoscopic means connected to the frame means and extending distally therefrom, cartridge means for storing at least one surgical staple at the distal end portion, the staple being configured and
10 adapted to attach an object to body tissue. Means is provided for individually advancing the at least one staple distally for positioning adjacent the body tissue, and anvil means is provided for closing the staple in a manner to encompass at least a portion of the object and to penetrate
15 the body tissue to attach the portion of the object to the body tissue.

In the preferred embodiment, the apparatus
includes on the elongated endoscopic means, means for
engagably receiving and supporting the cartridge in a manner
20 to advance the staples individually for endoscopic application.

A cartridge is also disclosed for containing a plurality of surgical staples for fastening body tissue which comprises housing means adapted to support the
25 plurality of surgical staples, and means dimensioned, positioned and adapted to engage each staple as the staple is advanced from the housing means in a manner to prevent the staple from deforming out of the plane of the staple when the staple is deformed to attach the staple to body
30 tissue.

1 Th invention also relat s to a system for
attaching surgical m sh to body tissue adjacent a tissue
repair within a body cavity which comprises, a frame, and an
elongated endoscopic section connected at the proximal end
5 thereof to the frame and extending distally therefrom, the
endoscopic section configured and adapted for insertion into
an endoscopic cannula within the body cavity. The
endoscopic section includes a disposable cartridge adapted
to store a plurality of surgical staples in stacked
10 relation, the cartridge being removably engagably supported
by a pivotal support member, each staple being formed of a
first length of wire having at least one leg portion at each
end extending generally perpendicular to said first length
of wire, the leg portions being continuous with said first
15 length of wire and configured to facilitate insertion into
surgical mesh and adjacent body tissue therebeneath when
said staple is advanced toward said mesh, the staple further
being configured to facilitate folding said legs inwardly
toward said first length of wire when at least a portion of
20 the first length of wire is supported against anvil means,
whereby said leg portions and said first length of wire grip
said mesh and the body tissue therebetween to attach at
least the gripped portion of the mesh to the body tissue.
Means is provided for individually advancing the staples
25 distally for positioning adjacent the mesh and the body
tissue. Means is also included for providing perceptible
tactile indicator when each staple is advanced to a
predetermined position. Means is provided for closing each
said staple while said staple is advanced toward said mesh
30 and the body tissue so as to penetrate said mesh and the
body tissue while causing said leg members to fold inwardly

1 toward said first wire of said staple to grip said mesh and
the body tissue between said first wire and said legs.

A method is disclosed for endoscopically applying
surgical staples to attach objects such as surgical mesh to
5 body tissue comprising the steps of storing at least one
surgical staple cartridge positioned at the distal end
portion and adapted for advancing and closing the staple,
positioning the object adjacent the body tissue for
attachment to the body tissue, and advancing the surgical
10 staple distally so as to penetrate the object and the body
tissue and to close the staple at least sufficient to attach
said portion of the object to the body tissue.

A kit is disclosed for endoscopic application of a
surgical staple adapted to attach surgical mesh to body
15 tissue in hernia repair, which comprises surgical mesh,
cannula means, and apparatus for endoscopic application of a
surgical staple adapted to attach the surgical mesh to body
tissue. The apparatus includes frame means, and generally
elongated endoscopic means connected to said frame means and
20 extending distally therefrom and dimensioned and configured
for insertion into the cannula means. The endoscopic means
includes a removable and replaceable cartridge for storing a
plurality of surgical staples at the distal end portion, the
staple configured and adapted to attach objects to body
25 tissue, means for individually advancing the at least one
staple distally for positioning adjacent the surgical mesh
and the body tissue, and anvil means for closing the staple
at least sufficient to encompass at least a portion of said
surgical mesh and to penetrate said surgical mesh and the
30 body tissue in a manner to attach the portion of the
surgical mesh to the body tissue.

1 BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention are described hereinbelow with reference to the drawings wherein:

5 Fig. 1 is a perspective view from above, of an apparatus constructed according to the present invention for applying surgical staples to attach objects to body tissue;

Fig. 1A is a perspective view of the distal end portion of the apparatus of Fig. 1 illustrating an
10 alternative embodiment for pivoting the staple storage magazine;

Fig. 2 is an exploded perspective view with parts separated, of the handle of the instrument of the invention and the associated components;

15 Fig. 3 is a cross-sectional view taken along lines 3-3 of Fig. 1, illustrating the handle mechanism of the instrument in the pre-fired condition;

Fig. 4 is a cross-sectional view taken along lines 4-4 of Fig. 3 illustrating the mechanism at the proximal end
20 of the instrument for providing controlled distal movement to advance and to close staples at the distal end;

Fig. 5 is an enlarged cross-sectional view of the pawl and ratchet system in the handle which prevents proximal movement of the staple advancing system after
25 distal movement has begun;

Fig. 6 is a view similar to Fig. 5 illustrating the pawl and ratchet system of Fig. 5 after a staple has been fired and during the proximal movement of the firing mechanism;

30 Fig. 7 is a cross-sectional view similar to Fig. 3 with the staple advancing actuating handle in the full

1 proximal pivoted position corresponding to firing of a staple;

Fig. 8 is an enlarged cross-sectional view taken along lines 8-8 of Fig. 1 illustrating the rotating mechanism for the endoscopic portion and the system for pivoting the staple storage magazine from the proximal end;

Fig. 9 is a cross-sectional view taken along lines 9-9 of Fig. 8;

Fig. 10 is a cross-sectional view taken along lines 10-10 of Fig. 8 illustrating the system for providing pivotal motion of the staple storage magazine located at the distal end;

Fig. 11 is a cross-sectional view taken along lines 11-11 of Fig. 9 illustrating further details of the system for providing pivotal motion to the staple magazine at the distal end;

Fig. 12 is a view of the interior surface of the inner sleeve of the manually operable collar of Figs. 8-11, projected as a flat surface to illustrate the helical groove provided for coaction with a pin to provide pivotal motion for the staple magazine at the distal end;

Fig. 13 is a perspective view of an internal sleeve and pin which coacts with the inner sleeve shown in Figs. 11 and 12 which forms part of the system for pivoting the staple magazine at the distal end;

Fig. 14 is an exploded perspective view with parts separated, of the endoscopic section of the instrument of the invention, illustrating the staple advancing system and components thereof;

Fig. 15 is an exploded perspective view with parts separated, of the staple storage magazine which is

1 controllably pivotally mounted at the distal end portion of
the endoscopic section;

Fig. 16 is a cross-sectional view taken along
lines 16-16 of Fig. 1 illustrating the distal end of the
5 instrument including the pivotal staple magazine at three
positions;

Fig. 17 is a cross-sectional view taken along
lines 17-17 of Fig. 16 illustrating the staple next in line
and the pusher plate provided for advancing the staple
10 toward a staple closing anvil;

Fig. 18 is a cross-sectional view of the distal
end of the instrument shown in engagement with a surgical
mesh positioned against body tissue prior to firing the
staple;

15 Fig. 19 is a cross-sectional view taken along
lines 19-19 of Fig. 18;

Fig. 20 is a cross-sectional view similar to Fig.
18 during the firing of the staple and after penetration
into the mesh and body tissue, but prior to closure;

20 Fig. 21 is a view similar to Fig. 19, taken along
lines 21-21 of Fig. 20;

Fig. 22 is a cross-sectional view of the distal
end of the instrument of the invention after closure of the
staple in position to attach the surgical mesh to the body
25 tissue;

Fig. 23 is a cross-sectional view taken along
lines 23-23 of Fig. 22 illustrating the staple ejection
system for releasing the closed staple from the anvils after
firing;

30 Fig. 24 is a cross-sectional view similar to Fig.
22 illustrating the staple after closure about the surgical

1 mesh and body tissue and the distal end of the instrument
withdrawn from the surgical mesh;

Fig. 25 is a cross-sectional view taken along
lines 25-25 of Fig. 24;

5 Fig. 26 is a cross-sectional view of the distal
end portion of the staple storing magazine of the instrument
after firing a staple;

Fig. 27 is a frontal view of a repair in body
tissue illustrating one example of an arrangement of staples
10 of the invention for attachment of reinforcing surgical mesh
to the tissue;

Fig. 28 is a perspective view of a staple
constructed according to the invention for attaching
surgical reinforcing mesh to body tissue over a surgical
15 repair;

Fig. 29 is another example of arranging the
staples for attachment of the reinforcing surgical mesh to
the body tissue in the area of a hernia repair;

Fig. 30 is a perspective view from above similar
20 to Fig. 1, of an alternative embodiment of the present
invention which includes a replaceable staple storing
cartridge at the distal portion of the endoscopic section;

Fig. 31 is an exploded perspective view with parts
separated, of the handle of the instrument of Fig. 30
25 illustrating a feature which provides perceptible tactile
sensing of the pre-positioning of each staple prior to
closing the staple with respect to the body tissue;

Fig. 32 is an exploded perspective view with parts
separated, of the system at the distal end portion of the
30 endoscopic section for pivotally supporting a replaceable
staple storage cartridge;

1 Fig. 32A is an exploded perspective view of the
staple storage cartridge with parts separated;

 Fig. 32B is a view taken along lines 32B-32B of
Fig. 32A, illustrating the "L" shaped staple holders on the
5 bottom of the cartridge housing;

 Fig. 33 is a side elevational view of the distal
portion of the endoscopic section illustrating the staple
storage cartridge support member and the staple storage
cartridge in position for insertion onto the support member;

10 Fig. 34 is a plan view from above of the staple
storage cartridge and related pivotal support member
illustrating the feature of the invention which prevents
each staple from rolling backwardly as they are deformed;

 Fig. 35 is a cross-sectional view of the staple
15 storage cartridge and related pivotal support member taken
along lines 35-35 of Fig. 30;

 Fig. 36 is a cross-sectional view taken along
lines 36-36 of Fig. 35 illustrating the initial position of
the staple indicator when the cartridge is loaded with a
20 full complement of staples;

 Fig. 37 is a cross-sectional view taken along
lines 37-37 of Fig. 35 illustrating the staples stacked
within the cartridge;

 Fig. 38 is a cross-sectional view of the staple
25 storage cartridge and related support member after the last
staple has been fired;

 Fig. 39 is a partial internal view of the handle
portion and the staple storage cartridge illustrating the
perceptible tactile staple pre-positioning feature of the
30 invention;

1 Fig. 40 is a perspectiv view of the internal
sleeve and pin which forms part of the pivoting system for
the staple storage cartridge, similar to the sleeve
disclosed in Fig. 13 in connection with the previous
5 embodiment of the invention; and

Fig. 41 is a cross-sectional view taken along
lines 41-41 of Fig. 30, illustrating schematically gaseous
seal means for the endoscopic section.

10 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS
 GENERAL

In general, the objective of the apparatus is to
store a plurality of staples in the magazine as will be
described in greater detail, and to individually advance
15 each staple distally for closure about anvils while
attaching a surgical mesh to the body tissue.

Following a general description of the present
instrument, the description will be divided into separate
sections to describe the structure and the desired movements
20 produced thereby. Those sections include the handle
section, the staple storage magazine pivoting system, the
endoscopic section and staple firing system, the staple
storage magazine, the staple closing system and the
inventive staple. Also a kit for attaching objects such as
25 surgical mesh is described.

THE INSTRUMENT

Referring initially to Fig. 1 there is illustrated
in perspective view the apparatus 10 particularly adapted
30 for endoscopic application of surgical staples to attach
surgical mesh to body tissue during hernia repair. Except

1 where noted otherwise, the materials utilized in the
components of the apparatus generally include such materials
as polycarbonate for housing sections and related
components, and stainless steel for such components which
5 transmit forces. One preferred polycarbonate material is
LEXAN brand polycarbonate available from General Electric
Company. Other specific preferred materials such as nylon
or glass filled nylon (for strength) are also utilized.
However, equivalent alternative materials will readily come
10 to the mind of those skilled in the art.

The apparatus 10 includes handle portion 12, and
endoscopic section 14 having at the distal end portion a
staple storage magazine 16 which pivots with respect to at
least one side of the longitudinal axis extending centrally
15 through the endoscopic section as shown in Fig. 1.
Generally, staple storage magazine 16 will selectively pivot
up to about 45 degrees with respect to the aforesaid
longitudinal axis. In the illustration of Fig. 1 the staple
storage magazine 16 is shown in general alignment with the
20 longitudinal axis of the endoscopic section and in phantom
to illustrate a range of movement. The total range of
pivotal motion of the staple storage magazine 16 as shown is
approximately 90 degrees, i.e. 45 degrees to each side of
neutral.

25 Referring generally to Fig. 1, the handle 12 of
instrument 10 includes manual grip 18 and pivotal trigger 20
which is pivoted toward and away from manual grip 18.
Trigger 20 is pivoted toward manual grip 18 during the
staple advancing and firing sequence which will be described
30 in further detail. Trigger 20 pivots away from manual grip

1 18 to return the instrument to the pre-fired condition in position for firing the staple next in line.

A double knurled finger operative collar 22 is rotatable and adapted to rotate the entire endoscopic section 14 a full 360 degrees as will be described hereinbelow, while proximal movement of the finger ring 22 produces pivotal motion of the staple storage magazine to one of the positions shown in phantom in Fig. 1. To achieve the other position shown in phantom in that Fig., the collar 22 may be simply rotated 180 degrees thereby rotating the entire endoscopic section and causing the position of the magazine 16 to be reversed as shown to the other position shown in phantom. Thus, it can be seen that the combination of full rotation of the endoscopic section and the pivotal movement of the staple storing magazine facilitates a wide range of articulation of the distal end of the staple magazine 16, thus facilitating application of staples over a wide range of locations (± 180 degrees) and in any of a plurality of orientations. In the embodiment of the invention shown in the Figs., when the collar 22 is moved to its proximalmost position the staple magazine is in one of the positions shown in phantom in Fig. 1, i.e. at an angle with respect to the longitudinal axis of the instrument. When the collar 22 is advanced to the distalmost position the staple magazine assumes the position shown in Fig. 1, i.e. in alignment with the longitudinal axis of the instrument.

Thus, in the preferred embodiment of Fig. 1, it can be seen that the full 90 degrees of movement of the magazine may be achieved simply by longitudinal movement of collar 22 in combination with full rotation of the

1 endoscopic section. The longitudinal movement of collar 22
causes pivotal movement of the staple storing magazin to 45
degrees in one direction and rotation of the endoscopic
section provides completion of the articulation of the
5 magazine. Both of these movements in combination,
facilitate a wide range of maneuverability of the distal end
of the staple magazine 16, thus facilitating application of
staples over a wide range of locations (± 180 degrees) and
in any of a plurality of orientations.

10 Alternatively, the positions of the staple storing
magazine 16 may be achieved as shown in Fig. 1A, i.e. by
movement of the magazine between zero degrees and about 45
degrees on either side of the longitudinal axis. In such
arrangement, to achieve the positions shown in phantom in
15 Fig. 1A, the collar 22 is moved distally and proximally,
equal distances on either side of a neutral detent.
Movement in one direction would pivot the magazine to one
side and movement in the other direction would cause pivotal
movement of the magazine in the opposite direction. The
20 directions selected would be arbitrary. However, in this
last described embodiment the orientation of the magazine
would be the same throughout the 90 degree pivoting range,
whereas in the preferred embodiment of Fig. 1, the
orientation of the magazine when on one side is opposite the
25 orientation when on the other. Further, in this embodiment
the endoscopic section will be somewhat longer to
accommodate the additional movement of collar 22.

THE HANDLE SECTION

30 Referring to Fig. 2, there is shown an exploded
perspective view with parts separated, of the handle of th

1 instrument with associated components. The handle is
comprised of an outer housing preferably formed of separate
sections as shown, of polycarbonat material. The separate
parts shown are attached by welding, adhesives, etc. Fig. 3
5 illustrates a cross-sectional view of the handle mechanism
taken along lines 3-3 of Fig. 1. The ultimate purpose of
the handle mechanism is to provide controlled distal
movement to the pusher assembly 24, a portion of which is
shown in Fig. 2. The pusher assembly extends through the
10 endoscopic section 14, a portion of which is shown in
phantom in Fig. 2. In the embodiment shown, the endoscopic
section shown is intended to be permanently and rotatably
attached to the instrument via rim 16a formed on bushing 16
and rim 15a on half round sleeve 15. The instrument shown
15 is contemplated to be entirely disposable. Half round
sleeve 15 is integrally formed with barrel 17 which is in
turn affixed to handle 12 at the nose piece 13.

However, it is also contemplated and within the
scope of the invention to construct the endoscopic section
20 to be selectively detachable whereby the handle may be
sterilized and reused, or the endoscopic section can be
sterilized, and the staple storage magazine re-loaded with
staples for re-use. Alternatively a replacement staple
magazine, and optionally a replacement endoscopic section,
25 may be detachably secured to a disposable handle for
multiple use during a single surgical procedure. Thus, any
combination of alternatives may be incorporated within the
scope of the invention.

Referring now to Fig. 2 in conjunction with Figs.
30 3, 7 and 14, pusher assembly 24 includes flanged thrust bar
26 connected to firing rod 28 by lost motion connector 30 as

1 shown in Fig. 3. Lost motion connector 30 is a bar having a
generally "U-shaped" configuration as shown. The lost
motion connector 30 provides a positive connection between
flanged thrust bar 26 and firing rod 28, yet provides a
5 small space between the firing rod and the thrust bar 26 as
will be described. Since the respective slots 28a and 26a
in the firing rod 28 and in the thrust bar 26 are
dimensioned slightly larger in width than the thickness of
the legs 30b and 30c of the lost motion connector 30 which
10 are received in these slots, a small degree of relative
movement (i.e., about one tenth (1/10) of an inch) is
provided permitted between the components in the staple
firing chain. This small degree of movement is provided for
several reasons as follows: 1) minor pivotal proximal
15 movements of the trigger mechanism will not immediately
result in engagement between the pusher assembly and the
staple next in line, thus avoiding inadvertent distal
movement of the staple during handling by operating room
personnel, or positioning by the user; 2) engagement of the
20 pusher assembly with the next staple will not occur until
the pawl and ratchet plate of the clutch mechanism
(described hereinbelow) takes place, thus preventing
inadvertent partial advancement of several staples at a
time. This would occur if the operator were allowed to
25 partially activate the trigger mechanism several times over
the same part of its cycle. The clutch mechanism prevents
such movements. Further, this free movement of the thrust
bar 26 also permits the staple advancing and forming
components to engage each other smoothly without jamming or
30 intercomponent interference with themselves and with the
components of the system for pivoting the staple storage

1 magazine 16 as will be described hereinbelow. Explanation
of the pivoting system for the staple storage magazine will
illustrate the advantages of the lost motion connector bar
in further detail.

5 Trigger mechanism 20 is pivotally attached at
pivot pin 32 for pivotal movement toward and away from
handle grip 18, and is adapted to produce upward and
downward rotational movement of triangular member 34 when
horizontal pin 36, attached to trigger mechanism 20,
10 traverses an upward arc whose center of rotation is located
at pivot pin 32. Thus, it can be seen that when handle grip
18 is positioned in the palm of the user's hand and trigger
mechanism 20 is squeezed toward handle grip 18, horizontal
pin 36 traverses an upward arc while engaging the longer
15 side 34a of triangular member 34 as shown. This movement
causes triangular member 34 to rotate upward in a
counterclockwise direction while upright member 35 to which
it is attached, pivots forwardly about a point of rotation
defined by pivot pin 37 located at the lowermost end of a
20 handle grip 18 shown in Fig. 2.

As can be seen in Figs. 2 and 3, pusher assembly
24 is connected to upright member 35 through aperture 33
such that inward squeezing of trigger mechanism 20 will
cause the entire pusher assembly to advance distally against
25 the constant force provided by negator spring 40 as shown.
The negator spring 40 is formed of a resilient flat spring
material coiled about the rotational bar 42 which is
rotationally mounted about cross member 44 which forms part
of bracket 46. The free end of negator spring 40 is
30 attached to an anchor pin 48 via aperture 49 as shown, while
the spring 40 is normally biased toward the coiled

1 configuration as shown in Fig. 3. It can therefore be
appreciated that after squeezing trigger mechanism 20 the
full stroke from the position shown in Fig. 3 toward handle
grip 18 to the position shown in Fig. 7, release of the
5 trigger mechanism will permit the negator spring 40 to
assume control and to return rotational bar 42 to the pre-
fired proximal location by the automatic winding action of
the negator spring 40 to its original unloaded
configuration. This motion in turn causes the entire pusher
10 assembly 24 to return to the proximalmost pre-fired position
as shown in Fig. 3. The constant force of negator spring 40
uniquely prevents the natural tendency of the user to rotate
the hand as with springs which increase in force when
progressing through a full spring cycle.

15 Referring once again to Figs. 2 and 3, trigger
stop device 50 is attached to trigger mechanism 20 and is
configured and dimensioned for engagement with handle grip
18 in a manner to thereby limit the proximal pivotal
movement of trigger mechanism 20. Depending upon the
20 particular limits required in the apparatus, trigger stop
device 50 can be dimensioned accordingly.

Referring now to Figs. 4-6, the structure and
function of the uni-motion clutch mechanism will be
described. This clutch mechanism prevents proximal movement
25 of the pusher assembly in the event the trigger mechanism is
released after the squeezing motion of the trigger mechanism
and the advancement of the pusher assembly has begun but
before the full stroke is completed. The clutch mechanism
is self-releasing when the pusher assembly reaches the
30 distalmost position, thus permitting the entire pusher
assembly to return to the pre-fired, or proximalmost

1 condition, and the trigger mechanism to also return to the
pre-fired position.

Referring now to Fig. 4 in conjunction with Figs.
5 and 6, ratchet plate 52 is fixed to barrel 17 and
5 therefore fixed with respect to the handle housing and
possesses a surface defined by a plurality of right angle
triangular shaped parallel ridges 56 as shown in Figs. 4-6.
Pawl 58 is rockably mounted for distal and proximal movement
with pusher assembly 24 through barrel 17, and is biased
10 toward ratchet plate 52 by resilient wire spring 60 as
shown. The location of pawl 58 shown in Fig. 4 corresponds
to the pre-fired condition of the apparatus with negator
spring 40 in the fully wound position and pawl 58 located
proximal of ratchet plate 52. Further, pawl 58 is
15 preferably of stainless steel while ratchet plate 52 is made
of brass or other compatible material.

While trigger mechanism 20 is squeezed toward
handle grip 18 producing distal motion of the entire pusher
assembly 24, pawl 58 engagably slides distally past the
20 ratchet surface 56 of ratchet plate 52 as shown in Fig. 5
such that one corner of the tip 62 of the pawl 58
sequentially engages each right angled ridge of ratchet
plate 52 to thereby prevent proximal movement of the pusher
assembly in the event the trigger mechanism is released by
25 the operator. The engagement of pawl 58 with ratchet plate
52 provides audible confirmation that the pusher assembly is
moving distally since the user will hear a series of
progressive audible clicks. This action - which is best
shown in Fig. 5 - continues with the tip 62 of pawl 58
30 sliding past the ratchet surface of the ratchet plate 52

1 until the pawl is positioned distally of the distalmost
tooth.

After completion of the staple firing stroke and
upon release of the trigger mechanism 20 the pawl 58 moves
5 proximally with the pusher assembly as described under the
action of spring 40. The end portion 62 of pawl 58 which is
now free, engages the distal end of the ratchet plate 52
causing the pawl to rock to the reverse direction shown in
Fig. 6 so as to slide proximally past the ratchet surface of
10 ratchet plate 52 without interference to the proximal
movement of the pusher assembly 24. Thus, it can be seen
that the clutch mechanism as described will effectively
permit squeezing the trigger mechanism 20 toward the handle
grip 18 while maintaining all positions midway through the
15 stroke in the event the operator releases the grip, while
permitting return motion thereof after the stroke has been
completed. The clutch mechanism also allows the operator to
advantageously preposition a staple such that the legs of
the staple protrude from the distal end of the staple
20 magazine discussed hereinafter, and then to release pressure
from the trigger mechanism. The operator may then turn full
attention to locating the prepositioned staple in the
desired target location, at which point the pivoting of the
trigger mechanism may be resumed and the cycle completed.
25 This staple prepositioning greatly facilitates staple
placement.

THE STAPLE STORAGE MAGAZINE PIVOTING SYSTEM

Referring to Figs. 8-14, the system for pivoting
30 the staple storage magazine located at the distal end of the
endoscopic section 14 will now be described. Fig. 8

1 illustrates double knurled finger operable collar 60 which
is mounted for rotation with the endoscopic section 14 by
inwardly extending pin 62 which is slidably positioned
within longitudinal groove 64 in the outer housing half
5 section 14a of endoscopic section 14, as shown in further
detail in Fig. 14. Thus collar 60 is readily slidable
distally and proximally while pin 62 slides within groove
64. Thus while permitting slidable movement of collar 60,
pin 62 prevents independent rotation of collar 60 relative
10 to the endoscopic section 14. Accordingly, when collar 60
is gripped between the user's fingers and rotated, the
endoscopic section 14 rotates with the collar.

Positioned within finger operable collar 60 is
helically grooved inner sleeve 66 fabricated of a suitable
15 plastic material such as nylon, glass filled for strength.
Helically grooved inner sleeve 66 is generally cylindrical
in shape and includes a helical groove 68 shown in phantom
lines in Fig. 8 and illustrated schematically in the
projected frontal view of the sleeve shown in Fig. 12. The
20 sleeve 66 is fixedly attached to outer collar 60 for
rotation therewith. In the projected view of Fig. 12, the
helical groove appears as a diagonal groove having a linear
shape. In Fig. 11, finger operable collar 60 is shown in
cross-section and the inner helically grooved sleeve 66 is
25 shown whereby helical groove 68 is represented at two
locations as viewed in Fig. 11. In Fig. 11, the cross-
section of groove 68 at the 10 o'clock position (where lines
11-11 are located in Fig. 9) is just distal of the cross-
section of groove 68 shown in phantom at the 12 o'clock
30 position.

1 Referring now to Fig. 8 in conjunction with Figs.
9-13, elongated internal cylindrical sleeve 70 is positioned
partially within inner helically grooved sleeve 66 and
collar 60 when collar 60 is in the distalmost position, as
5 shown in Fig. 8; however, when collar 60 is withdrawn to the
proximalmost position as shown in phantom lines in Fig. 8,
the major portion of internal cylindrical sleeve 70 is
positioned within collar 60 as shown. Internal sleeve 70 is
preferably of nylon (preferably glass filled for strength)
10 and defines a distal face 72 which is generally oriented at
an acute angle with respect to the longitudinal axis of the
instrument as shown clearly in Figs. 8 and 13. The sleeve
70 contains pin 74 extending radially outwardly from the
outer surface as shown. Pin 74 is preferably of steel or it
15 may be formed of nylon integral with sleeve 70. Pin 74 is
positioned for slidable movement within the helical groove
68 of inner sleeve 66 of collar 60 such that proximal
movement of collar 60 will cause pin 74 to follow the groove
68 causing sleeve 70 to rotate in one direction. Similarly,
20 distal movement of collar 60 to the position shown in
phantom lines in Fig. 7 will cause pin 74 to traverse groove
68 in the opposite direction thereby causing sleeve 70 to
rotate in the opposite direction.

The significance of the rotational motion of
25 sleeve 70 as it pertains to the pivotal motion of staple
storing magazine 16 will be described in further detail
hereinbelow. At this stage, however, it is sufficient to
state that the obliquely oriented distal face 72 of sleeve
70 engages the proximal ends of a pair of longitudinally
30 extending push rods 76, 78 shown in phantom lines in Fig. 13
and more clearly in Fig. 14 such that when collar 60 is

1 moved distally or proximally, inner sleeve 70 also rotates
and the rods 76,78 respectively move in equal and opposite
directions by the engagement with different portions of
oblique distal face 72 with these rods. In essence, one rod
5 is engaged by a surface portion distal of the surface
portion on the side of face 72 which engages the other rod.
Thus, when the sleeve 70 is rotated in one direction, rod 78
moves in the distal direction while rod 76 withdraws
proximally the same distance, and when sleeve 70 is rotated
10 in the opposite direction, rod 76 moves in the distal
direction and rod 78 moves proximally the same distance.

Collar 60 contains rotary ridges 60a in the distal
half and longitudinal ridges 60b in the proximal half, and
is thus conveniently movable longitudinally and rotatably by
15 the user when the appropriate knurled portion is gripped
between the user's fingers. However, the operator need not
grip the collar 22 at any specific locations. The ridges
may be formed integral by molding procedures or
alternatively may be in the form of knurled surfaces. The
20 rotary ridges respectively permit collar 60 to be finger
movable distally and proximally, while the longitudinal
ridges assist in rotation of collar 60 by hand. Rotational
motion of the collar causes the endoscopic portion 14 to
rotate while proximal movement of the collar in a preferred
25 embodiment causes staple storing magazine 16 to pivot up to
about 45 degrees in one direction with respect to the
longitudinal axis of the instrument as shown in Fig. 1.
Distal movement of the collar 60 to the distalmost position
shown in Fig. 8, causes staple storing magazine 16 to
30 withdraw to the original orientation shown in Fig. 1 which
is generally in line with the endoscopic section. Thus, by

1 pivoting the staple storing magazine up to 45 degrees and by
rotating the endoscopic portion 14, the total range of
movement of the staple storing magazine is 45 degrees to
either side of the endoscopic section traversing a total of
5 90 degrees of effective pivotal movement. With respect to
movements of collar 60, the direction which produces pivotal
motion of staple storage magazine 16 away from the
longitudinal axis or toward the axis is clearly a matter of
choice and would be determined by the respective
10 configurations of the coacting components.

In the alternative embodiment shown in Fig. 1A,
the internal sleeve 70 and forward face 72 are configured
such that collar 22 may be positioned midway between
proximal and distal positions. The mid-position will
15 correspond to the staple storage magazine being at zero
degrees with respect to the longitudinal axis. Collar
movement in one direction from neutral will produce up to 45
degrees of pivotal movement of magazine 16 and collar
movement in the other direction on the side of neutral will
20 produce pivotal movement of the magazine 16 up to 45 degrees
in the other direction. A major distinction in this
embodiment is that the actual orientation of the magazine
with respect to the longitudinal axis will differ on either
side of neutral.

25 Referring now to Figs. 15 and 16, the system for
providing pivotal motion to the staple storing magazine 16
is illustrated at the distal end of the instrument. In Fig.
16 the staple storage magazine 16 is shown in the position
generally in alignment with the endoscopic section and is
30 shown in phantom lines at the pivoted locations
corresponding to plus or minus 45 degrees. The staple

1 storage magazine is formed of an outer housing of a suitable
plastic material such as polycarbonate and is comprised of
upper housing half section 16a and lower housing half
5 housing half section 16a contains an indentation 80 at the
proximal end having a "V-shaped" cross section and the lower
housing half section 16b contains a similar indentation 82
also having a "V-shaped" cross section as shown. Both
10 indentations 80,82 are adapted to respectively engagably
receive the distal ends of rods 76,78 (which are rounded)
such that when the rods are respectively and alternately
moved in the proximal and distal directions as described
hereinabove, one rod may advance distally to cause the upper
15 housing to rotate and the other rod withdraws to permit the
pivotal motion of the staple magazine. For example, as
shown in Fig. 16, when rod 78 moves distally, engagement of
the tip of the rod 78 with indentation 80 in upper housing
16a of staple storing magazine causes the staple magazine to
pivot downwardly as shown in phantom.

20 Similarly, equal and oppositely withdrawing rod 76
will accommodate the downward movement of the staple storing
magazine 16. In a similar fashion when the collar 60 is
moved in the opposite distal direction the movement of each
rod is respectively reversed causing rod 76 to move distally
25 and to engage the lower housing 16b of staple storing
magazine 16 and rod 78 withdraws to accommodate the pivotal
movement of staple storing magazine back to the original (or
neutral) position in general alignment with the endoscopic
section as shown in Fig. 16. The lost motion connector 30
30 clearly provides a minor degree of space (i.e. about 1/10

1 inch) between the components, which space provides the advantages mentioned previously.

Alternatively one rod may be provided and connected to the staple storage magazine and adapted to pivot the magazine by causing such rod to move proximally and distally thereby actually pivoting the magazine about the pivot point.

The endoscopic section 14 is shown clearly in Fig. 14 and is mounted for rotation relative to the handle section 18. As noted above, the endoscopic section may be permanently attached to handle 12 as shown in a disposable instrument; alternatively as noted above, it may be removably attached to a re-usable handle, or a variety of other combinations or configurations.

15

THE ENDOSCOPIC SECTION

Referring again to Fig. 14 the endoscopic section is shown in exploded view with parts separated for convenience of illustration and includes upper housing half section 14a and lower housing half section 14B. The housing half sections are preferably of a polycarbonate material such as LEXAN brand material mentioned previously, and are attached by welding, adhesives, etc. Positioned within the upper and lower housing half sections is pusher assembly 24 as described in more detail below, and anvil extension 88, formed of stainless steel and having a pair of elongated legs 90,92 which are joined at 94 at the distal end and which contain upwardly extending feet 88b,88b at the proximal end. As shown in Fig. 15, anvil extension 88 is attached at the distal end 94 to the staple storing magazine 16 by pivot pins 89 where the staple storing magazine is

35

1 pivotally attached. The proximal connection points of anvil
extension are best illustrated in Fig. 2 wherein upwardly
bent feet 88a, 88b are positioned within slots 15b in half
round collar 15 which is fixedly attached to handle housing
5 12 by barrel 17 and nose piece 13 and related support
members provided therein.

Anvil extension 88 is fabricated of stainless
steel and its purpose is to stabilize the dimension of the
endoscopic section 14 to prevent the forces acting on the
10 components from stretching or compressing the upper and
lower housing half sections 14a, 14b of the endoscopic
section which are constructed of a polycarbonate material
such as LEXAN brand material. Thus, the steel anvil
extension provides dimensional stability to the endoscopic
15 section while the endoscopic section is supporting the
components being subjected to forces for supporting,
advancing and forming the surgical staples as will be
described.

20 THE STAPLE FIRING SYSTEM

Referring further to Fig. 14, the steel pusher
assembly 24 is formed of firing rod 28 connected to flexible
elongated firing wire 102 which is in turn connected to
pusher plate assembly 104 as shown. The connection between
25 firing rod 28 and firing wire 102 is a crimped or swaged
connection at 106, whereas the connection between firing
wire 102 and pusher 105 is accomplished by an interference
fit between the firing wire 102 and collar 108 which is
attached to pusher plate 104. Firing rod 28 and pusher
30 plate 104 are preferably made of stainless steel whereas
firing wire 102 is made to be resiliently flexible

1 to accommodate the pivotal movement of the staple storing
magazine 16 since firing wire 102 is located within the
instrument at the location of staple magazine 16. In
particular, firing wire 102 is preferably made of a super
5 elastic metal. One example of such super elastic metal is
NITINOL brand metal available from Raychem Corporation,
Menlo Park, California. This material has a reduced
tendency to fatigue after a substantial number of cycles of
deflection caused by pivoting the staple storage magazine.
10 Other resilient materials are also contemplated for firing
wire 102.

THE STAPLE STORAGE MAGAZINE

Referring now to Figs. 15 through 18, there is
15 illustrated further details of the staple storing magazine
16. As noted previously, the staple storing magazine 16 is
comprised of upper housing half 16a and lower housing half
16b suitably attached by welding, adhesives, etc. The
magazine is adapted to contain a plurality of surgical
20 staples 110 which are particularly shaped to penetrate and
to attach surgical mesh to body tissue. For particular
details of the shape of the staples constructed according to
the invention, reference is made to Fig. 28.

Referring once again to Figs. 15-18, a particular
25 feature of the present invention resides in the system of
storage of the staples 110 which are positioned in adjacent
stacked relation whereby the stack of staples forms an angle
with the longitudinal axis of the instrument of
approximately 45 degrees as shown in Fig. 18. One purpose
30 of stacking the staples as shown is to provide greater
visibility to the user by the fact that the outer surface of

1 the upper housing half section adjacent the stack of staples
forms a similar angle and provides visibility to the user at
the distal end of the staple storage magazine. Angular
stacking of the staples as shown greatly facilitates storage
5 of a plurality of staples in a structure configured and
dimensioned for use in endoscopic applications, e.g., for
use through a trocar guide tube of diameter of about 12 mm
for example. The stack of staples 110 as shown in Fig. 18
is positioned and retained in such position by a resilient
10 spring member 113 having dual resilient legs and whose side
profile is curved as shown in Fig. 18.

The distal end of each leg engages the uppermost
staple follower 114 in the form of a nylon insert having a
general "H-shaped" configuration and dimensioned sufficient
15 to cover the staples as best shown in Fig. 15. The nylon
follower is intended to transmit the downward force of the
~~staple retainer spring 113 so as to distribute the force on~~
the stack of staples in a manner to facilitate a constant
and uni-directional downward force on the lowermost staple
20 which is positioned for advancement and deformation. It
also functions to advance the stack of staples downwardly
when the lowermost staple is fired. Steel anvil plate 120
is shown in Fig. 15 and includes upwardly extending feet 116
and 118 which form anvils at the distal end as shown in Fig.
25 15, for forming the staple therearound.

Thus, as seen in Fig. 18, the lowermost staple is
identified by numeral 110L and is in a position for
engagement by pusher plate 104 when the pusher assembly is
advanced distally. The pusher plate 104 is shown clearly in
30 Figs. 15 and 18 and contains distally advancing lands 104R
and 104L shown clearly in Figs. 15 and 19 at the distal end

1 to facilitate transmission of advancing force to the two
rounded or arcuate bridge portions of the staple. This
relative complementary configuration of the pusher plate 104
and the staple 110 facilitates efficient and uniform
5 distribution of force to the staple when it is deformed
about the anvil members as will be described.

THE STAPLE CLOSING SYSTEM

Referring now to Figs. 17-24 there is illustrated
10 the sequential views of the staple advancing and closing
system between the pre-fired and fired condition of the
staple. In particular, the staple and pusher mechanism are
shown in Fig. 17 in the pre-fired condition while the staple
shown in Fig. 24 is embedded within the body tissue in a
15 manner to retain the surgical mesh to the body tissue.

In Fig. 17, the staple pusher assembly 24 is
positioned proximal of the lowermost staple 110L and pusher
plate 104 is correspondingly positioned proximal of the
lowermost staple 110L. In Figs. 18 and 19 the pusher plate
20 104 has been partially advanced distally and the lowermost
staple 110L has been advanced distally of the stack of
staples 110 in a manner such that the pusher plate 104 has
now replaced lowermost staple 110L thereby preserving the
integrity and position of the stack of staples 110. The
25 preservation of the stack of staples 110 is provided by the
fact that the thickness of the staple pusher plate 104 is
either identical to or slightly less than the thickness of
the staples to assume that the plate 104 will engage only
one staple at a time.

30 Referring further to Figs. 20 and 21 the pusher
plate 104 has now advanced distally sufficient to cause the

1 staple to penetrate the surgical mesh 112 and the body
tissue 114. As shown in Figs. 20 and 21, it can be seen
that anvil members 116 and 118 are positioned for engagement
by the straight sections of bridge portions 110BR and 110BL
5 of the back rib of the staple 110L such that engagement of
the staple by pusher plate 104 with the arcuate end corner
portions of the staple as shown will cause the staple to
deform in a predetermined manner as will be described.

In Figs. 22-24 the staple 110L is now shown in the
10 deformed condition about the anvil members 116 and 118 and
the straight portions 110S of the back rib of the staple 110
are still in engagement with the anvils 116,118. In Fig.
22, the staple has penetrated into the body tissue 114 and
has been deformed and in Fig. 24 the staple deformation is
15 completed in a manner to substantially retain the surgical
mesh 112 in attached position with respect to the body
tissue as shown in Fig. 22. The inwardly projecting central
portion or bight, 110C, of staple 110 is shown gripping the
mesh and tissue in cooperation with the staple legs as shown
20 in Fig. 24. However, release of the staples from the anvil
members 116,118 has not yet been completed.

Release of the staple from the anvil members
116,118 is readily accomplished by ejector spring 124 which
is a "U-shaped" resilient spring having upwardly biased legs
25 124R and 124L each positioned respectively as shown in Fig.
15. When the pusher plate 104 is in the position shown in
Fig. 20, the legs 124R and 124L of staple ejector spring are
retained in a downward position by lands 104R and 104L of
the pusher plate 104. However, when the pusher plate 104 is
30 moved to the distalmost position shown in Fig. 23, the
absence of the pusher plate permits staple ejector legs 124R

1 and 124L to resiliently deflect upwardly to their natural
configuration thereby creating a vertical separation between
the anvil members 116, 118 and the deformed staple, thus
releasing the deformed staple from the anvil members as
5 shown in Fig. 23. Continued proximal movement of the pusher
plate 104 causes withdrawal of the pusher plate to a
position entirely proximal of the stack of staples 110 as
shown in Fig. 26, causing the stack of staples to move
downwardly due to the downward force of resilient staple
10 retainer spring 113 to advance the lowermost staple to the
firing position.

Once the staple 110 is applied to the mesh 112 and
tissue 114 as shown in Figs. 22 and 24, the distal end of
staple storing magazine 16 is withdrawn as shown in Fig. 24
15 and preparation is made for application of the next staple.
Fig. 25 is a cross-sectional view taken along lines 25-25 of
Fig. 24 with the staple storing magazine withdrawn from the
surgical mesh and body tissue. Thereafter, the apparatus
may be repositioned to apply another staple, or even an
20 array of staples as shown in Figs. 27 and 29.

Referring once again to Fig. 27, there is
illustrated one form of surgical mesh repair of an opening
in the body utilizing the apparatus and staple according to
the invention. In the application shown in Fig. 27, a
25 surgical mesh is attached to the body tissue over the
opening as illustrated schematically at 114c in Fig. 27, and
staples 110 have been applied in a circular array as shown
to reinforce the repair. Beneath the mesh, the opening 114c
may have previously been repaired as well. In Fig. 29 an
30 alternative array of staples to apply mesh material to body
tissue is shown. In this embodiment the mesh material 112

1 is essentially formed as a circular patch and staples 110
are oriented in a radial direction and are attached around
the periphery of the patch such that one leg of the staple
pierces the mesh and the other leg pierces body tissue 114.
5 Essentially the staple bridges the periphery of the mesh
material as shown. Clearly, alternative forms and
arrangements are available to attach mesh or other surgery
related objects or prostheses to body tissue as may come to
the mind of persons skilled in the art.

10 It should be further noted that the repair of body
tissue utilizing surgical mesh as shown in Figs. 27 and 29
are exemplary, and that other applications of mesh and
staples may be utilized in a manner to either reinforce a
surgical repair or to encourage tissue growth. Such mesh
15 materials are typically disclosed in U.S. Patent Nos.
4,838,884, 4,665,221, 4,452,245, and 4,347,847. It is noted
that the staple constructed according to the invention as
shown in Fig. 28 is particularly adapted for attachment of
such mesh material to body tissue according to any number of
20 techniques which may readily come to the mind of those
skilled in the art. In fact, in some instances the mesh may
be formed as a plug for insertion into a surgical opening
and then stapled. Moreover, the apparatus and staple of the
present invention may be applied to attach other objects to
25 body tissue as may come to the mind of those skilled in the
art.

THE STAPLE

30 Referring now once again to Fig. 28, there is
illustrated the inventive staple 110 constructed according
to the invention. The staple 110 is particularly shaped as

1 shown, and is preferably formed of a length of wire of
titanium. Stainl ss steel or equivalent material is also
contemplated and the staple preferably has a rectangular
cross-section as shown. Other cross-sections may be used.
5 Typically, the wire will be about .38mm in width (dimension
w) and .51 mm in thickness (dimension T). The initial width
of the staple before closure (dimension A) is about 4.4mm
and the thickness dimension between the back rib and legs
after closure (i.e. dimension B in Fig. 24) is about 3mm.
10 Another example is a wire having a width of about .51 mm
(dimension W) and a thickness of about .38mm (Dimension T).
The width before closure (dimension A) is about 8.64mm and
the thickness between the back rib and legs after closure is
about 2.5mm (dimension B in Fig. 24). The staple 110 has a
15 central bight portion 110c and a wire leg member 110R and
110L extending generally perpendicular to the central
portion as shown. Each leg member 110R, 110L is connected
to the central portion 110c by a bridge portion 110BR, 110BL
having an arcuate corner portion as shown. Each leg member
20 has a sharp tip for penetrating mesh and body tissue. Right
leg member 110R further possesses a tapered surface 110TR at
the tip which is opposite the position of the tapered
surface 110TL at the tip of the other leg member 110L as
shown in Fig. 28.
25 When the staple shown in Fig. 28 is advanced
toward dual spaced anvils 116,118 as shown in Fig. 21 for
example, and staple pusher plate 104 as shown, engages the
arcuate portions of the bridge portions 110BR and 110BL, the
legs of the staples are made to fold inwardly toward each
30 other as shown for example in Fig. 22, with one leg crossing
over the other. The cross-over configuration is

1 automatically assumed by the legs because of the presence of
tapered surfaces 110TR and 110TL which act as camming
surfaces tending to bias each leg away from the other
thereby tending to cross the legs in the manner shown. This
5 structure also prevents interference of the legs when folded
toward each other.

Thus, it can be seen that the particular shape of
the staple as shown, promotes a unique folding pattern for
the legs which achieves the configuration shown in the bent
10 staples of Figs. 22 and 24. Note in particular that
inwardly bent central portion 110c promotes positive
attachment of the mesh to the tissue by providing a gripping
system between inwardly projecting bight portion 110c and
leg members 110R and 110L with mesh and tissue gripped
15 therebetween. This staple shape combines with the
arrangement of the anvils and the particularly configured
pusher plate 104 to cause the staple to pierce mesh and body
tissue up to a predetermined extent. At this point,
continued application of force to the staple causes the
20 staple legs to fold upon themselves as shown in the drawings
while encompassing a sufficient portion of the mesh to
attach the mesh to the body tissue. Thus the staple pieces
folds and grips in substantially a single movement.

In practice, the laparoscopic procedures to repair
25 tissue in hernia repair using surgical mesh is similar in
some respects to the surgical procedures to gall bladders,
appendix, lungs, etc. In particular, the endoscopic tubular
section of the apparatus is inserted into the cannula which
is positioned within the opening in the body. Provision is
30 made between the cannula and the endoscopic section to seal
the connection therebetween and provision may also be

1 provided to seal the actual endoscopic apparatus from
leakage of fluids or insufflating gaseous media. An
exemplary cannula assembly including seal means is disclosed
for example in commonly assigned U.S. Patent No. 4,943,280,
5 issued July 24, 1990, the disclosure of which is
incorporated herein by reference.

THE KIT

10 The present invention is readily adaptable to be
provided to surgeons in the form of a kit in which all
necessary equipment and accessories are provided in sterile
form ready for use in surgery. For example, an apparatus
constructed according to the invention can be readily
packaged with a supply of staples (i.e. up to 12 or more
15 staples) and sufficient mesh material for completing the
hernial repair. The mesh material is typically about 1 mm
in thickness. The components may be provided separately as
a matched kit, or in a blister type or other package,
suitable and ready for use by the surgeon and the surgeon's
20 assistants. The apparatus and staples can be provided in
any size matched to meet the apparatus and mesh material in
accordance with the particular needs of a contemplated
hernial surgical procedure. In addition, the kit can
include a matching trocar assembly with appropriate valve
25 assembly to prevent loss of the insufflating gas from the
peritoneum between the trocar and the outside surface of the
endoscopic section. Since the outer housing of the
endoscopic section is substantially closed at the point of
attachment of the staple magazine, release of insufflating
30 gases through the staple magazine and the endoscopic section
housing is either non existent or minimal. Such trocar

1 assembly is available from United States Surgical
Corporation, Norwalk, Connecticut, under the trademark
SURGIPOINT brand trocar assembly.

5 A typical endoscopic section may be a 12mm
diameter with a staple magazine capable of holding up to 10
staples of appropriate size. The length of the endoscopic
section is typically 14 to 15 inches. An endoscopic section
in the embodiment shown will be about 14 inches. However,
if pivotal movement of the staple storage magazine is to be
10 provided between plus 45 degrees and minus 45 degrees solely
by distal and proximal movement of collar 22, the endoscopic
section will be structured to greater in length, i.e. about
15 inches. The trocar assembly will be of matching size,
i.e., 12mm, to accommodate the endoscopic section and to
15 prevent release of gases thereby. The mesh material
provided with the kit will be of mesh size comparable for
use with the size of the staples provided in the kit.

Thus by structuring the apparatus to provide such
sealing, the endoscopic application of staples to attach
20 objects such as surgical mesh to body tissue can be readily
accomplished. Accordingly, the present invention is not
only directed to the apparatus for applying such staples to
body tissue, but also to a kit in which the apparatus is
uniquely combined with a supply of staples, surgical mesh,
25 cannula assembly etc. whereby the surgeon may readily
perform the necessary procedures.

AN ALTERNATIVE EMBODIMENT

30 In the following description of an alternative
embodiment of the invention, like components will be
identified by numerals similar to the numerals for like

1 components in the previous embodiments except that they will
be preceded by the numeral "2". Accordingly, for example,
the entire apparatus of the previous embodiment was
identified in the description as numeral "10". In Fig. 30,
5 for example, the apparatus is identified by numeral "210".

Referring now to Fig. 30, there is illustrated a
perspective view of an alternative embodiment of the
apparatus constructed according to the invention in which
the staples are stored in a cartridge which is self-
10 contained and which is readily insertable at the distal
portion of the endoscopic section of the apparatus as shown
in Fig. 33. The apparatus 210 includes handle portion 212
and endoscopic section 214 having at the distal end portion
a staple storage cartridge support means 266 on which is
15 supported staple storage cartridge 216. Generally, it may
be stated that the staple cartridge support member 266 is
pivotally mounted to the distal portion of the endoscopic
section and such pivotal motion will result in similar
pivotal motion of the staple storage cartridge 216 since the
20 cartridge is directly supported by the pivotal support
member. The pivotal motion of the staple storage cartridge
support member and related mechanism is identical to the
mechanism described previously in connection with the first
embodiment.

25 Referring now to Fig. 31 the components which form
the handle 212 are shown and are in many respects identical
to the components and function of the handle shown in Fig.
2. The handle components shown in Fig. 31, however include
an additional feature which provides a manual tactile feel
30 to assist the user in knowing when the staple is at a
particular visible position shown in Fig. 39. One way this

1 can be achieved is shown in Fig. 31 whereby arcuately shaped
notch 233 is incorporated into the triangular member 234 and
is configured and dimensioned similar to the pin 236. When
trigger 220 is manually squeezed by the user toward upright
5 member 235 causing horizontal pin 236 to traverse an upward
arc as described in connection with the previous embodiment
the pin 236 engages the longer side 234a of triangular
member 234. Thus, each time the trigger 220 is squeezed a
sufficient distance, the pin 236 will enter arcuately shaped
10 notch 233 so as to provide the user with an actual
indication by feel of the location of the pin with respect
to the longer side 234a of triangular member 234. At this
point along the path of pin 236 the staple 210, next in
line, will be at the same partially advanced distal location
15 which is shown in Fig. 39. Thus, when the user senses or
feels the detent of the entry of pin 236 into notch 233 an
actual perceptible tactile indicator of the position of the
staple next in line is thus provided. This partially
advanced position of the staple facilitates visual
20 examination of the staple to assist the user in selecting
the proper position or location and/or orientation which
would be appropriate for the particular staple application
which is in progress. At all times, however, while trigger
220 is being squeezed, the uni-motion clutch mechanism 200
25 will prevent retracement of the trigger until the full
stroke has been completed, as described previously. It
should be noted that other means, including visible and
audible, can be utilized to achieve the advantageous
provision of indicating to the user when the staple is in
30 its partially advanced position.

1 Referring now to Figs. 32 and 32A, the unique
replaceable staple cartridge system constructed according to
the present invention is disclosed. In contrast to the
embodiment described hereinabove the staple storage magazine
5 and pivoting system has been replaced by the combination of
a replaceable staple storage cartridge 216 shown with parts
separated in Fig. 32A and a pivotal staple cartridge support
system 215 shown with parts separated in Fig. 32. In
summary, the pivotal staple cartridge support system is
10 permanently attached for pivotal movement via pins 289 with
respect to the endoscopic section 210 and the cartridge 216
is readily insertable with respect to the support system as
shown in Fig. 33.

 Referring once again to Fig. 32 the staple
15 cartridge support system includes support member 266 having
proximal upper face member 215 permanently attached thereto
by ultrasonic welding, gluing etc. The entire assembly is
attached for pivotal movement to endoscopic section 210 via
pins 289. As described in the previous embodiment the
20 pivotal movement of the staple cartridge support member 266
and related components is capable of extending up to about
45° with respect to the central axis of the endoscopic
section 210. However, as noted previously this cartridge
support system may be arranged to pivot from about +45° to
25 about -45° by dimensioning the pivoting system
appropriately.

 The pivotal movement of the staple cartridge
support system shown in Fig. 32 is identical in all respects
to the pivotal movement of the staple storage magazine
30 described in connection with the previous embodiment and

1 shown particularly in Fig. 15. However, in the staple
cartridge support system in Fig. 32 the structure has been
modified as shown to accommodat the removable and
replaceable staple cartridge 216. For example, at the
5 distal end portion of the staple cartridge support system
there is shown cartridge support plate 217 which includes a
lip 217a at the proximal end for reception of the distal
tips 216a of the cartridge housing to retain the cartridge
216 in position on the support member 266. In addition
10 cartridge support plate 217 includes distally extending leg
members 217b which in turn include tip portions 217c which
extend distally of the tip of cartridge support member 266
as shown more clearly in Fig. 33. The tip members 217c
extend not only distally but also inwardly as shown clearly
15 in Figs. 32 and 34 so as to provide an increased staple
contact surface and backing support for each staple as it is
advanced distally and as it is deformed. This feature
prevents the staple from curling rearwardly as it is being
deformed in the event such tendency may be present. Thus,
20 this feature provides resistance to backward roll for each
staple.

Referring once again to Fig. 32a and Fig. 32b the
cartridge 216 is shown and is assembled to contain a
plurality of staples which are preloaded and a spring 213
25 having distally extending legs 213a adapted to bias staples
210 in a direction toward the anvil 220 via staple follower
214 constructed of a suitable material such as nylon. The
staples are contained in cartridge 216 by "L" shaped holders
216g on the lower face of the cartridge 216 as shown in Fig.
30 32B. In the present embodiment, the staple follower 214 is
similar to staple follower 114 of the previous embodiment

1 but contains a proximally extending extension 214a
terminating in head 214b which extends into the space 213b
defined by the legs 213a of spring 213.

5 The cartridge 216 is inserted into position as
shown in Fig. 33 and is retained by positioning distal tips
216a into respective spaces 217e formed on each side between
face member 215 and cartridge support member 266. Central
partition 217d becomes positioned within the space 216k
between cartridge distal legs 216L to stabilize the
10 cartridge in position. Downwardly extending cartridge legs
216h shown more clearly in Figs. 34, 35 and 36 are
configured as shown, to resiliently snap into elongated
apertures 215a in face member 215 as shown in Fig. 36 to
retain the cartridge in position when it is rotated
15 thereinto in the direction of arrow A as shown in Fig. 33.
Thus, it is preferable to fabricate the housing of cartridge
216 of a resilient plastic material.

The operation of the staple follower 214 is
clearly illustrated in Figs. 35 through 38. In Fig. 35, the
20 staple cartridge 216 is shown with a full complement of
staples 210 and the proximal portion 214a of staple follower
24 is shown extending upwardly through the legs 213a of
spring 213. A window 216c is provided in the upper housing
216b of cartridge 216 to facilitate visibility of the staple
25 follower when all staples have been spent and the proximal
head 214b of staple follower 214 moves upwardly into the
window 216b as shown in Fig. 38, by the action of spring
213. Thus, the user is provided with an immediate visible
indicator when all staples have been spent.

30 In addition, it is desirable to fabricate staple
follower 214 of a bright colored plastic material such as

1 nylon. For example, follower 214 could be fabricated of a
bright yellow material at least at the head 214b such that a
visible indication will be provided by head 214b after the
last staple has been spent. In assembled condition, the
5 head 214b and extension 214a will be positioned in space
213b between legs 213a of spring 213 as shown in Figs. 35
and 38. In addition, it is desirable to color the area 216d
of upper housing 216b of the cartridge 216 in a color
similar to the color of the extension 214a of follower 214.
10 For example, follower 214 may be colored black in its
entirety with the exception of head 214b which would be
colored bright yellow.

The area 216d of the upper housing 216b (shown by
the stippled portions in Figs. 32A and 34) can also be
15 colored black. Thus, when a full complement of staples 210
is provided as in Fig. 35, the black portion of extension
214a of follower 214 will appear through window 216c and
this black color will complement the black colored area 216d
shown by stippling in Fig. 34. Follower 214 is fabricated
20 of a resilient material such as nylon and is configured to
be upwardly biased against the inner ceiling 216j as the
staples are individually dispensed. When the last staple
has been dispensed and closed as shown in Fig. 38, the
yellow colored head 214b of follow 213 will snap upwardly
25 under its own resilience to thereby appear through window
216c and the user will therefore be provided with an
immediate visible indication that the last staple has been
spent. Thereafter, the cartridge may be simply removed by
lifting it away from the pivotal support member 266 in the
30 direction opposite the direction shown by the arrow A shown

1 in Fig. 33. The cartridge may be replaced by a fully load d
cartridge and the surgical operation may proceed.

Another feature of the cartridge of the present
invention is the provision of colored circular dots 216e
5 and 216f. One of each such circular dot is shown on upper
cartridge housing 216b by circles surrounded by stippled
areas in Figs. 32A and 33. By placing the user's thumb and
first middle finger on the two dots 216e on each side of the
upper housing 216b, and the index finger on the forward dot
10 216f, the cartridge may be simply lifted from the pivotal
support member 266 causing cartridge legs 216h to release
their snap grip on face member 215. Thereafter, a full
cartridge may be replaced in the same, but reverse fashion
by positioning tips 216a into space 217e and snapping legs
15 216h into position with apertures 215a. The circular dots
216e and 216f can be provided in any suitable color which is
readily observable to the user. For example, these circular
dots may be provided in the color black, which would be
readily visible in contrast to the yellow indicator of head
20 214b of staple follower 214.

Referring now to Fig. 40, there is illustrated a
circular sleeve 270 similar to the circular sleeve 70 shown
in Fig. 13 in connection with the previous embodiment. The
circular sleeve 270 is identical in all respects to the
25 cylindrical sleeve 270 of the previous embodiment and is
configured as a camming surface adapted to engage push rods
276, 278 to pivot the cartridge support member 266 and the
staple cartridge 216 in the same manner as described in
connection with the previous embodiment. In Fig. 40 grooves
30 270a and 270b are illustrated to provide a positive stop
which corresponds to the engagement of push rod 276, 278

1 with grooves 270a and 270b when the staple storage cartridge
support system 266 is in the pivotal position, i.e.
approximately 45° with respect to the endoscopic section.
The positive stop which is provided by the engagement of the
5 push rods 276, 278 with the grooves 270a and 270b is
identical to the operation of sleeve 70 described in
connection with the previous embodiment. However,
optionally additional grooves 270c and 270d may be provided
in sleeve 270 corresponding to pivotal locations of the
10 cartridge support member 266 which are less than the full
pivotal movement of the support system, i.e. 25°. These
optional grooves will facilitate providing a perceptible
tactile indication to the user of the location of the
cartridge and related support system in terms of pivotal
15 angle with respect to the endoscopic section. Optionally
any number of such grooves may be provided dependent upon
the particular needs of the user and the particular surgical
procedures required. Thus, the instrument may be provided
with any number of combinations of the above-described
20 features.

Fig. 41 is a cross-sectional view taken along
lines 41-41 of Fig. 30, illustrating schematically a gaseous
seal means in the form of silicone grease 250 to prevent the
insufflating gaseous media from escaping from the patient's
25 body cavity through the instrument. Such gaseous seal means
may alternatively be in the form of a separate seal block
positioned within the endoscopic section, or it may
alternatively be in the form of a gaseous sealing block
located either in another portion of the endoscopic section
30 or alternatively in the handle section.

1 The present embodiment may be incorporated into
kit form as in the previously described embodiment. Also,
combinations of features of the present embodiment may be
combined with features described in connection with the
5 previous embodiment as may become apparent to persons
skilled in the art.

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